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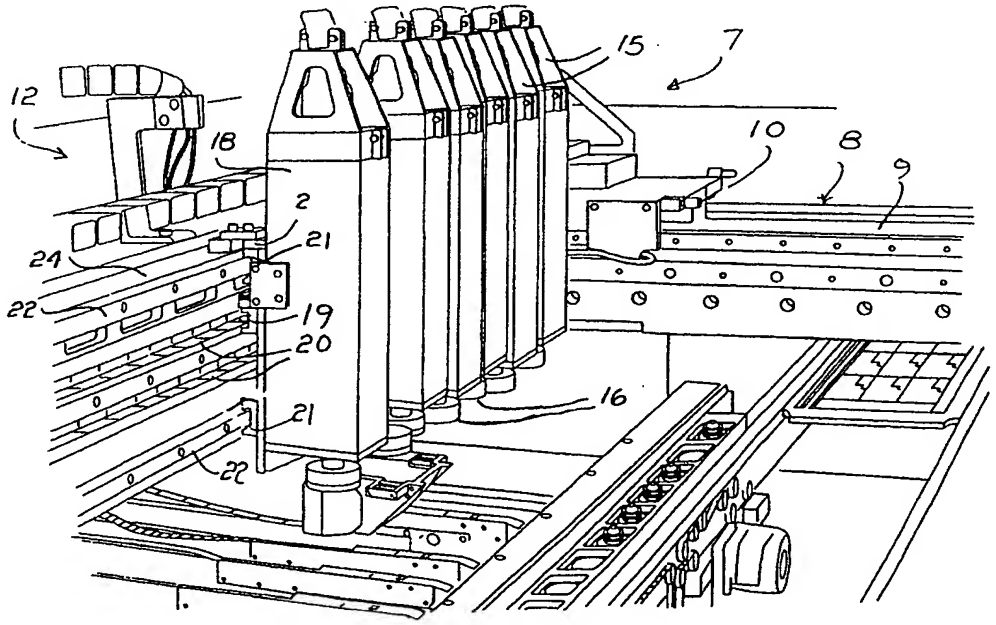

(57) Abstract

A placement system (1) has a pair of gantry beams (12) each supporting six placement heads (20) and a camera (30) on the opposite side. All are independently driven by linear motors. The six heads pick six components simultaneously according to a programmed picking configuration. Each beam (12) is coupled to fixed rails (8) by couplers (11) and the linear motors are controlled to skew the beam. This allows the heads to move two–dimensionally with respect to each other for multiple simultaneously placement.

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"A Component Placement System"

Introduction

Field of the Invention

The invention relates to a system for placing components in an automated production process. An example is placement of electronic components in a surface mount technology (SMT) process.

Prior Art Discussion

In recent years, significant strides have been made in providing computerised control of heads for picking and placing components on a substrate such as a printed circuit board. However, a problem with existing component placement systems is that production time is quite long where a large number of components must be placed on a substrate, as is the case in many SMT processes. This is because a head must move to a feeder, pick a component, convey the component to the substrate, accurately locate a target position on the substrate, and place the component on the substrate at that position. This cycle is repeated for each feed position. An improvement involves use of a head having multiple nozzles, and components are sequentially picked in a batch, and sequentially placed. Such a head is typically of the rotary type.

Objects of the Invention

The invention is directed towards providing a component placement system which operates more efficiently than as heretofore been the case.

Another object is that the system provides greater versatility by virtue of being capable of handling a wider range of different component feeding and placement configurations.

Another object is to achieve improved accuracy.

SUMMARY OF THE INVENTION

According to the invention, there is provided a component placement system comprising a component feeder, a component-carrying head, a drive means for moving the head between picking and placing positions, and a controller comprising means for controlling component picking and placing by the head, characterised in that, the system comprises a plurality of feeders, a plurality of independent heads, and the controller comprises means for controlling the drive means and the heads to simultaneously pick a plurality of components.

By providing a plurality of independent heads, the system may adapt to picking according to a variety of picking configurations in a versatile manner. For example, there may be a bank of feeders and a different subset of the bank is required for each successive batch. Because the heads are independent, there may be simultaneous picking from different subsets of the bank of feeders.

In one embodiment, the drive means comprises means for moving at least two heads with respect to each other in a two-dimensional plane, and for controlling simultaneous placement of at least two components at different locations in the two-dimensional plane.

In another embodiment, the drive means comprises a gantry system having a beam on which the heads are mounted at a carriage.

Preferably, the gantry system comprises means for causing both translational and rotational motion of the beam whereby heads move with respect to each other in a two-dimensional plane.

In one embodiment, the gantry system comprises means for moving a head independently in a direction different to that of the axis of the gantry beam.

In a further embodiment, the drive means comprises a linear motor mounted to cause movement of a head with respect to a carriage on the gantry beam..

In a still further embodiment, the gantry beam comprises at least two drive rails, and wherein carriages of alternate heads are on different rails so that the carriages can overlap in the direction of the beam axis to provide additional freedom of movement.

Ideally, the drive rails are linear motor magnetic rails, and the beam comprises a common encoding strip for all heads on a beam.

In one embodiment, the system comprises an inspection system having a camera and associated controller, a camera drive means for moving the camera to track a head for component inspection as the component is being conveyed to a placement position, and an image processor.

In another embodiment, the camera and the head are mounted on a common gantry beam.

Preferably, the camera is mounted on the opposite side of the gantry beam to the head, and the inspection system further comprises a light guide to provide an optical path from a component to the camera underneath the beam.

In one embodiment, the light guide comprises a beam splitter mounted to allow the camera view a component on the head, or below the head on a substrate.

Preferably, the inspection system further comprises a proximity sensor to detect the head and the camera controller comprises means for triggering an image grab when the head is detected.

In another embodiment, the system further comprising a mapping means comprising:-

means for directing a collimated beam of light in a linear direction across a workspace, and

and wherein the controller comprises:-

means for monitoring detection of the beam by the camera and for mapping the workspace according to deviations in the position of detection of the beam by the camera.

In one embodiment, the inspection system comprises a plurality of light sources directed to impinge light on a component for component inspection, wherein the light sources generate light of different wavelengths, one of which is reflected by the head surface and the other of which is not reflected by the surface to provide either backlight or frontlight illumination inspection by selection of a light source.

In the latter embodiment the surface may have a colour other than red, one light source emits infra red light which is reflected, and another light source emits red light which is not reflected.

In another embodiment, the inspection system comprises means for inspecting component local fiducials to determine location and orientation of components after placement.

In a further embodiment, the image processor comprises means for providing a captured image as a background and for superimposing representations of components to emulate an actual image of components on a substrate.

Preferably, the controller comprises means for sensing position of components ready to be picked and for controlling an adjustment means to adjust the component positions before picking to improve picking accuracy. The camera may be used to sense the component positions.

Preferably, each feeder comprises means for detecting its physical position in the system and for signalling position information to the system controller.

In the latter embodiment, the location identification means comprises means for detecting a voltage level on a voltage ladder extending across the feeders.

In one embodiment, the controller comprises means for sensing pressure in a component nozzle and placement force in real time to provide control for picking and placing.

Preferably, the heads are electrically connected to the controller by cables which slide on overhead carriages to avoid cable strain.

In another embodiment, a group of cables is bundled in a sleeve having an elongate fastener to allow opening and closing of the sleeve.

In one embodiment, the system is an electronic component placement system.

In another embodiment, the system comprises a bank of component feeders on each transverse side of a substrate conveying direction, and the gantry system comprises a beam associated with each feeder whereby the system is substantially symmetrical about the substrate conveying direction.

Preferably, the controller comprises means for directing heads of one beam to pick at the same time as heads of the other beam are placing.

According to another aspect, the invention provides a component placement system comprising a component feeder, a component-carrying head, a drive means for moving the head between picking and place positions, and a controller comprising means for controlling component picking and placing by the head, wherein the system further comprises an inspection system having a camera and associated controller, a camera drive means for moving the camera to track a head for component inspection as the component is being conveyed to a placement position, and an image processor.

Preferably, the camera and the head are mounted on a common gantry beam.

In one embodiment, the camera is mounted on the opposite side of the gantry beam to the head, and the inspection system further comprises a light guide to provide an optical path from a component to the camera underneath the beam.

Preferably, the light guide comprises a beam splitter mounted to allow the camera view a component on the head, or below the head on a substrate.

In one embodiment, the inspection system comprises a plurality of light sources directed to impinge light on a component for component inspection, wherein the light sources generate light of different wavelengths, one of which is reflected by the

head surface and the other of which is not reflected by the surface to provide either backlight or frontlight inspection by selection of a light source.

Preferably, the head has a surface with a colour other than red, one light source emits infra red light which is reflected for backlight component illumination, and another light source emits red light which is not reflected for frontlight component illumination.

According to another aspect, the invention provides a component placement system comprising a component feeder, a component-carrying head, a drive means for moving the head between picking and place positions, and a controller comprising means for controlling component picking and placing by the head and an image processor, wherein the image processor comprises means for providing a captured image as a background and for superimposing representations of components to emulate an actual image of components on a substrate.

According to another aspect, the invention provides a component placement system comprising a plurality of component feeders, a component-carrying head, a drive means for moving the head between picking and place positions, and a controller comprising means for controlling component picking and placing by the head, wherein each feeder comprises means for detecting its physical position in the system and for signalling position information to the system controller.

Preferably, the detecting means comprises means for detecting position on a voltage ladder extending across the feeders.

DETAILED DESCRIPTION OF THE INVENTION

Brief Description of the Drawings

The invention will be more clearly understood from the following description of some embodiments thereof, given by way of example only with reference to the accompanying drawings in which:-

Fig. 1 is a front view of a component placement system of the invention;

Fig. 2 is a side view of the system;

Fig. 3 is a perspective view showing a gantry system of the placement system;

Fig. 4 is a perspective view showing parts of heads to illustrate the manner in which they are connected to a gantry beam;

Fig. 5 is a diagrammatic front view showing movement of a pair of heads illustrating their freedom of movement;

Fig. 6 is a plan view of the gantry system;

Fig 7 is a diagrammatic cross-sectional side view of a beam showing the manner in which a camera is connected to the gantry beam for on-the-fly component inspection;

Fig. 8 shows an underneath perspective and underneath plan views of a head nozzle;

Fig. 9 is a diagrammatic view showing frontlight illumination of a component, and Fig. 10 is a diagrammatic view showing backlight illumination;

Fig. 11 is a perspective view of a component feeder;

Fig 12 is a diagrammatic side view showing component feed micro adjustment;

Fig. 13 is a more detailed perspective view showing a micro adjustment mechanism;

Fig. 14 is a detailed plan view showing a beam coupler to allow rotational and sliding motions of the gantry beam;

Figs. 15 and 16 are diagrammatic plan views showing two dimensional placement;

Fig. 17 is a diagrammatic plan view showing component position inspection; and

Fig 18 is a representation of a PCB showing components for enhanced reality.

Description of the Embodiments

Referring to the drawings and initially to Figs. 1 and 2 there is shown a component placement system 1. As is clear from Fig. 1, the system 1 is generally symmetrical about a longitudinal conveying path (through the plane of the page) for substrates

onto which components are placed by the system 1. In this embodiment, the system 1 is for placing surface mount components on a printed circuit board. The system 1 comprises a frame 2 which is generally symmetrical about the conveying direction. The path for printed circuit boards is indicated generally by the numeral 3 and it comprises a conveyor controlled to convey a circuit board into the system 1, leave it stationary for a required time period, and to subsequently move it to a solder reflow oven. The system 1 operates to place the components on the board, and to perform limited in-line quality control.

In more detail and referring to Figs. 2 to 6, the frame 2 supports a base table 4 mounted over a system controller 5 comprising rack-mounted circuits. The controller 5 has a display terminal 6. A drive means for moving the component-carrying heads comprises a gantry system 7 having a pair of fixed rails 8 extending perpendicular to the conveying direction of the circuits, referred to in this specification as the Y direction. Each of the fixed rails 8 comprises a linear motor track 9 on which runs two linear motor carriages each connected by a coupling 11 to a gantry beam 12. The coupling 11 allows rotational and also transverse movement of a pivot axis between it and the beam. This is to allow the beam to be skewed so that heads may move in a two-dimensional plane formed by the X direction (direction of the beam) and the Y direction (direction of the fixed rails) with respect to each other.

There are two beams 12, and the system controller 5 controls heads on one beam to pick components while simultaneously controlling heads on the other beam to place components to achieve a high efficiency.

The heads are indicated by the numeral 15, and each comprises a nozzle 16 which comprises a vacuum conduit for picking and placing a component. Each head 15 also comprises a base 17 and a casing 18 which contains circuits for decoding controller signals. Each head 15 is driven by a linear motor 19 running on a linear

motor track 20 on the beam 12. The head 15 runs on a pair of linear bearings 21 engaging rails 22. Signals from the controller 5 control the motor 19, and an encoder head 23 running on an encoding strip 24 feeds back positional information to the controller to complete a position control loop.

Each beam 12 comprises a pair of parallel linear motor tracks 20, one above the other. As is clear from the drawings, alternate heads 15 have motors 19 on different tracks. This allows the motors 19 to overlap as shown in Fig. 5 so that there is a greater degree of freedom of movement of each head and the minimum pitch for heads is much smaller than would otherwise be the case. Despite the fact that alternate heads are on different tracks, an encoding head 23 of each head engages a common encoding strip 24 for the beam. This allows relatively simple control signalling arrangements to be used despite the fact that there are two motor tracks.

The heads 15 are connected to the controller 5 by cable looms 28. The looms 28 are connected to carriages 29 which run on overhead rails to avoid cable strain. Each bundle of cables is held together by a sleeve which has a zip fastener extending along its length to allow easy opening and closing for addition, replacement, or repair of cables.

As shown in Fig. 7, the system 1 also comprises an inspection system comprising a camera 30 mounted on each beam 12, a light guide 31 for directing light to the camera via an optical path and an image processor connected to the system controller for processing images captured by the camera 30. The light guide 31 comprises a head mirror 32 at an angle of 45° to horizontal, a camera mirror 32 also at an angle of 45° a to horizontal, and a beam splitter 34 between the head and camera mirrors. The head mirror 33 is located underneath the line of movement of the nozzles 16 on the same beam. The camera 30 is mounted on a pair of linear bearings 21, one of which is underneath the beam 12. It is driven by a linear motor

19 in a manner similar to the heads 15. This allows the camera 30 to inspect a component on each nozzle as it is being moved to the placement position. This is very important as it provides component inspection on-the-fly, thus minimising time required for inspection because it is carried out simultaneously. All that is required is that the controller drive the camera to pass the mirror 32 under selected heads for inspection of various components according to an inspection strategy. The beam splitter 34 also allows the camera to inspect components underneath the optical path such as on the substrate. This provides excellent versatility.

Another important aspect of the inspection system is that the optical path includes two light sources to illuminate the nozzle during inspection.. Each nozzle 16 comprises a planar disc-shaped base 36 above a suction conduit 37. The base 36 has an absorbent green coating, which reflects infrared light, but not red light. The light guide comprises a pair of IR sources 39 on splayed sides of the guide 31 on each side of the head mirror 32. It also comprises a pair of red light sources 40 located on each side of the optical path to direct red light at a component via the mirror 32. The guide 31 also comprises a white light source 41 for the beam splitter 34. When the light sources 39 are activated there is backlight illumination because the base 36 appears bright, whereas when the red light sources 40 are activated there is frontlight illumination as the base 36 appears dark. This provides excellent flexibility. Fig. 9 shows frontlight illumination and Fig. 10 shows backlight illumination for a component 42.

Image grabs by the camera 30 are triggered by a proximity sensor 43 mounted on the camera 30 to detect a protruding tongue 44 of the target head. The sensor is connected to the camera and light controller, to cause the camera to capture an image. This is a very simple arrangement for triggering image grabs as it avoids the need for using computational resources. The image grab occurs as the camera and the head move relative to each other.

Referring to Figs. 11 to 13, components are fed by tape feeders 45, each of which supplies components from reels 46 by virtue of feeding mechanisms 47. The system controller is programmed to perform fine adjustment within a step range to adjust the position of a component before picking. The camera 30 detects position of components in the feeding mechanisms 47 before picking and in response the controller controls the adjustment mechanism to ensure that all components are in a correct position. This provides for faster picking and it also helps to ensure that the position of the component with respect to the nozzle is more predictable. Another major advantage is that very small components (in the region of 0.5 x 0.25 mm to 2.0 x 2.0 mm) may be accurately picked. Placement quality is also improved for the larger components.

Another aspect of the feeders 45 is that they include electrical contacts which engage with a resistor ladder when in position at the system 1. A controller in the feeder 45 monitors the voltage level of the contact and transmits a signal to the system controller 5 indicating its position in response to the sensed voltage. Each feeder position has a unique voltage level on the resistor ladder and this allows automatic notification of the position of each feeder. This is very important for control purposes. The voltage detectors are at the front of the feeding mechanisms 47.

The system 1 set-up is changed by the heads 15 automatically picking a desired nozzle 16 from a rack 50 mounted alongside the conveyor path 3. This is achieved by simply moving a nozzle coupler downwardly until it snap-fits with the desired nozzle 16 at a groove 38. The location of the nozzles is shown most clearly in Figs. 6, 15, and 16. This can be performed in a single efficient cycle by bringing a beam into line over a rack 50.

Figs. 14, 15, and 16 illustrate the manner in which the heads 15 may simultaneously pick up to six components at one time from the selected feeding mechanisms 47. Also, simultaneous placement is achieved by virtue of skewing the beam 12 as shown

in Figs. 15 and 16. The coupler 11 between the beam 12 and the fixed rail allows rotation and sliding of the beam with respect to the rail so that the heads may move with respect to each other in the X direction (axis of the beam) and in the Y direction perpendicular to this. Rotary motors on the heads rotate the nozzles to orientate the components correctly if the beam has been skewed. This is important as it compensates for the effect of skewing and achieves correct alignment of the components on the substrate. It will be appreciated that by skewing the beam 12 as shown in Figs. 15 or 16, the invention achieves not only simultaneous picking, but also simultaneous placement of two or more components.

Two-dimensional relative movement may be achieved also by each head being mounted on a carriage via an individual drive to provide movement in a direction having a Y component . This drive is controlled to provide the individual head additional movement direction. Such an arrangement may be instead of or in addition to skewing of the beam to achieve multiple simultaneous placement.

In more detail, the drive may be a linear motor drive . Also, it may be connected so that the head comprises only the nozzle 16 and associated connectors and moves relative to a casing much like the casing 22. Alternatively, the beam may comprise two spaced-apart parallel rails, and the drive is connected between them and moves on carriages on the rails. The head is mounted on the drive,

In general, the degree of movement required for this direction is under 30mm. Clearly, additional programming is required to control the head movement although the nature of the control is similar i.e. motor actuation and encoding feedback forming a position control loop.

The system is capable of automatically mapping the placement workspace. It does this by means of a laser source which is mounted to direct a collimated beam in a linear direction across the workspace. A 45° mirror is mounted below the camera 30.

The controller moves the camera 30 in the linear direction so that the camera should continuously see a spot. Deviations in position of this spot are monitored by the controller and are used to map the workspace. These deviations arise from mechanical inconsistencies in the bearings, in the beam, and general alignment. Instead of using a 45° mirror, a target may be used. The target being viewed by the camera.

The controller performs quality control automatically by moving the camera 30 to selected component positions after placement and taking an image which contains both the component and substrate local fiducials in the same field of view. The controller then computes X, Y and orientation offsets with respect to the reference position. The diagram of Fig. 17 shows a component 60, local fiducials 61, and a reference position 62 for the component. With this deviation data, the controller calculates statistical parameters, including the standard deviation and CPK in each direction for the full system and for each head 15.

Another aspect of the system is that it generates enhanced reality images of a complete PCB resembling images actually captured. This allows the user to check the product, the component locations, component value marks, and polarity marks without producing the product. It also allows the user to perform random checks of manufactured product without stopping the system as the images are generated off line.

In one aspect, a method is provided to check the component orientation and location. This enables the programmer to determine if the program data is correct As the program is being generated. An image of a PCB is obtained such as by the camera 30 taking images and the controller consolidating them or by scanning. The image is sized and is used as a background for the programming environment. As component data is entered, an icon representing the component is superimposed over the image at the programmed location and orientation. An example 70 is

shown in Fig. 18. Alternatively, the system may capture actual images of components from the feeders or elsewhere and use these instead of representations. In this case, the final image generated is of the PCB with images of the programmed components at the desired locations, orientations, polarities, values and so may be used to check a prototype before starting production, or to check that the production is still producing product according to the master document.

Another feature of the system 1 is that the controller 5 monitors nozzle vacuum pressure for holding a component and the linear motor drive current for moving the nozzle down for placement to achieve improved placement control in real time. The process is as follows:-

position the component a little above the placement position, calculated using the component height,

continue down until the real time force measurement indicates the placement force as required for this component,

switch off the vacuum and on the blow off,

monitor the vacuum at the nozzle tip using the vacuum sensor, and

withdraw the nozzle when the pressure rises above atmosphere.

The controller 5 also performs a control method for ensuring accurate picking of a component from a feeder using real time measurement of the placement force and the vacuum at the nozzle tip. This is as follows:-

position the nozzle over the pick position at the feeder,

continue down until the real time force measurement indicates the nozzle is touching the component,

switch on the vacuum and monitor the vacuum value at the nozzle tip and once the predefined value has been reached withdraw the nozzle with the component.

The latter value depends on the component whereby larger values are required for larger components.

The system therefore achieves much improved placement as it is independent of component type, its variations from specification, substrate levelling and warping. Also, the correct vacuum levels per component are reached before proceeding to the next step. The system also achieves much improved picking as it accommodates variations in feeder position, height, tape position and in the tape. It also ensures that the correct vacuum levels per component are reached before proceeding to the next step.

The invention is not limited to the embodiments described, but may be varied in construction and detail within the scope of the claims. For example, it may have only one head per beam at the expense of not providing simultaneous picking or placing. However, the benefits of on-the-fly inspection, backlight/frontlight illumination switching, feeder position detection, and enhanced reality image processing are still achieved.

Claims

1. A component placement system comprising a component feeder, a component-carrying head, a drive means for moving the head between picking and place positions, and a controller comprising means for controlling component picking and placing by the head, characterised in that, the system comprises a plurality of feeders, a plurality of independent heads, and the controller comprises means for controlling heads to simultaneously pick a plurality of components.

2. A system as claimed in claim 1, wherein the drive means comprises means for moving at least two heads with respect to each other in a two-dimensional plane, and for controlling simultaneous placement of at least two components at different locations in the two-dimensional plane.

3. A system as claimed in claims 1 or 2, wherein the drive means comprises a gantry system having a beam on which the heads are mounted at a carriage.

4. A system as claimed in claim 3, wherein the gantry system comprises means for causing both translational and rotational motion of the beam whereby heads move with respect to each other in a two-dimensional plane.

5. A system as claimed in claim 3, wherein the gantry system comprises means for moving a head independently in a direction different to that of the axis of the gantry beam.

6. A system as claimed in claim 5, wherein the drive means comprises a linear motor mounted to cause movement of a head with respect to a carriage on the gantry beam..

7. A system as claimed in any of claims 3 to 6, wherein the gantry beam comprises at least two drive rails, and wherein carriages of alternate heads are on different rails so that the carriages can overlap in the direction of the beam axis to provide additional freedom of movement.

8. A system as claimed in claim 7, wherein the drive rails are linear motor magnetic rails, and the beam comprises a common encoding strip for all heads on a beam.

9. A system as claimed in any of claims 3 to 8, further comprising an inspection system having a camera and associated controller, a camera drive means for moving the camera to track a head for component inspection as the component is being conveyed to a placement position, and an image processor.

10. A system as claimed in claim 9, wherein the camera and the head are mounted on a common gantry beam.

11. A system as claimed in claim 10, wherein the camera is mounted on the opposite side of the gantry beam to the head, and the inspection system further comprises a light guide to provide an optical path from a component to the camera underneath the beam.

12. A system as claimed in claim 11, wherein the light guide comprises a beam splitter mounted to allow the camera view a component on the head, or below the head on a substrate.

13. A system as claimed in any of claims 9 to 12, wherein the inspection system further comprises a proximity sensor to detect the head and the controller comprises means for triggering an image grab by the camera when the head is detected.

14. A system as claimed in any of claims 10 to 13, further comprising a mapping means comprising:-

means for directing a collimated beam of light in a linear direction across a workspace, and

and wherein the controller comprises:-

means for monitoring detection of the beam by the camera and for mapping the workspace according to deviations in the position of detection of the beam by the camera.

15. A system as claimed in any of claims 9 to 14, wherein the inspection system comprises a plurality of light sources directed to impinge light on a component for component inspection, wherein the light sources generate light of different wavelengths, one of which is reflected by the head surface and the other of which is not reflected by the surface to provide either backlight or frontlight inspection by selection of a light source.

16. A system as claimed in claim 15, wherein the surface has a colour other than red, one light source emits infra red light which is reflected and another light source emits red light which is not reflected.

17. A system as claimed in of claims 9 to 16, wherein the inspection system

comprises means for inspecting component local fiducials to determine location and orientation of components after placement.

18. A system as claimed in any of claims 9 to 17, wherein the image processor comprises means for providing a captured image as a background and for superimposing representations of components to emulate an actual image of components on a substrate.

19. A system as claimed in any preceding claim, wherein the controller comprises means for sensing position of components ready to be picked and for controlling an adjustment means to adjust the component positions before picking to improve picking accuracy.

20. A system as claimed in claim 19, wherein the controller comprises means to direct the camera to sense the component positions.

21. A system as claimed in any preceding claim, wherein each feeder comprises means for detecting its physical position in the system and for signalling position information to the system controller.

22. A system as claimed in claim 21, wherein the location identification means comprises means for detecting a voltage level on a voltage ladder extending across the feeders.

23. A system as claimed in any preceding claim, wherein the controller comprises means for sensing pressure in a component nozzle and placement force in real time to provide control for picking and placing.

24. A system as claimed in any preceding claim, wherein the heads are electrically

connected to the controller by cables which slide on overhead carriages to avoid cable strain.

25. A system as claimed in claim 24, wherein a group of cables is bundled in a sleeve having an elongate fastener to allow opening and closing of the sleeve.

26. A system as claimed in any preceding claim, wherein the system is an electronic component placement system.

27. A system as claimed in any of claims 3 to 26, wherein the system comprises a bank of component feeders on each transverse side of a substrate conveying direction, and the gantry system comprises a beam associated with each feeder, whereby the system is substantially symmetrical about the substrate conveying direction.

28. A system as claimed in claim 27, wherein the controller comprises means for directing heads of one beam to pick at the same time as heads of the other beam are placing.

29. A component placement system comprising a component feeder, a component-carrying head, a drive means for moving the head between picking and place positions, and a controller comprising means for controlling component picking and placing by the head, wherein the system further comprises an inspection system having a camera and associated controller, a camera drive means for moving the camera to track a head for component inspection as the component is being conveyed to a placement position, and an image processor.

30. A system as claimed in claim 29, wherein the camera and the head are mounted on a common gantry beam

31. A system as claimed in claim 30, wherein the camera is mounted on the opposite side of the gantry beam to the head, and the inspection system further comprises a light guide to provide an optical path from a component to the camera underneath the beam.

32. A system as claimed in claim 31, wherein the light guide comprises a beam splitter mounted to allow the camera view a component on the head, or below the head on a substrate

33. A system as claimed in any of claims 29 to 32, wherein the inspection system comprises a plurality of light sources directed to impinge light on a component for component inspection, wherein the light sources generate light of different wavelengths, one of which is reflected by the head surface and the other of which is not reflected by the surface to provide either backlight or frontlight inspection by selection of a light source.

34. A component placement system as claimed in claim 33, wherein the head has a surface with a colour other than red, one light source emits infra red light which is reflected for backlight component illumination, and another light source emits red light which is not reflected for frontlight component illumination..

35. A component placement system comprising a component feeder, a component carrying head, a drive means for moving the head between picking and place positions, and a controller comprising means for controlling component picking and placing by the head and an image processor, wherein the image processor comprises means for providing a captured image as a background

and for superimposing representations of components to emulate an actual image of components on a substrate.

36. A component placement system comprising a plurality of component feeders, a component-carrying head, a drive means for moving the head between picking and place positions, and a controller comprising means for controlling component picking and placing by the head, wherein each feeder comprises means for detecting its physical position in the system and for signalling position information to the system controller.

37. A component placement system as claimed in claim 36, wherein the detecting means comprises mean for detecting a voltage level on a voltage ladder extending across the feeders.

38. A component placement system substantially as described with reference to the drawings.

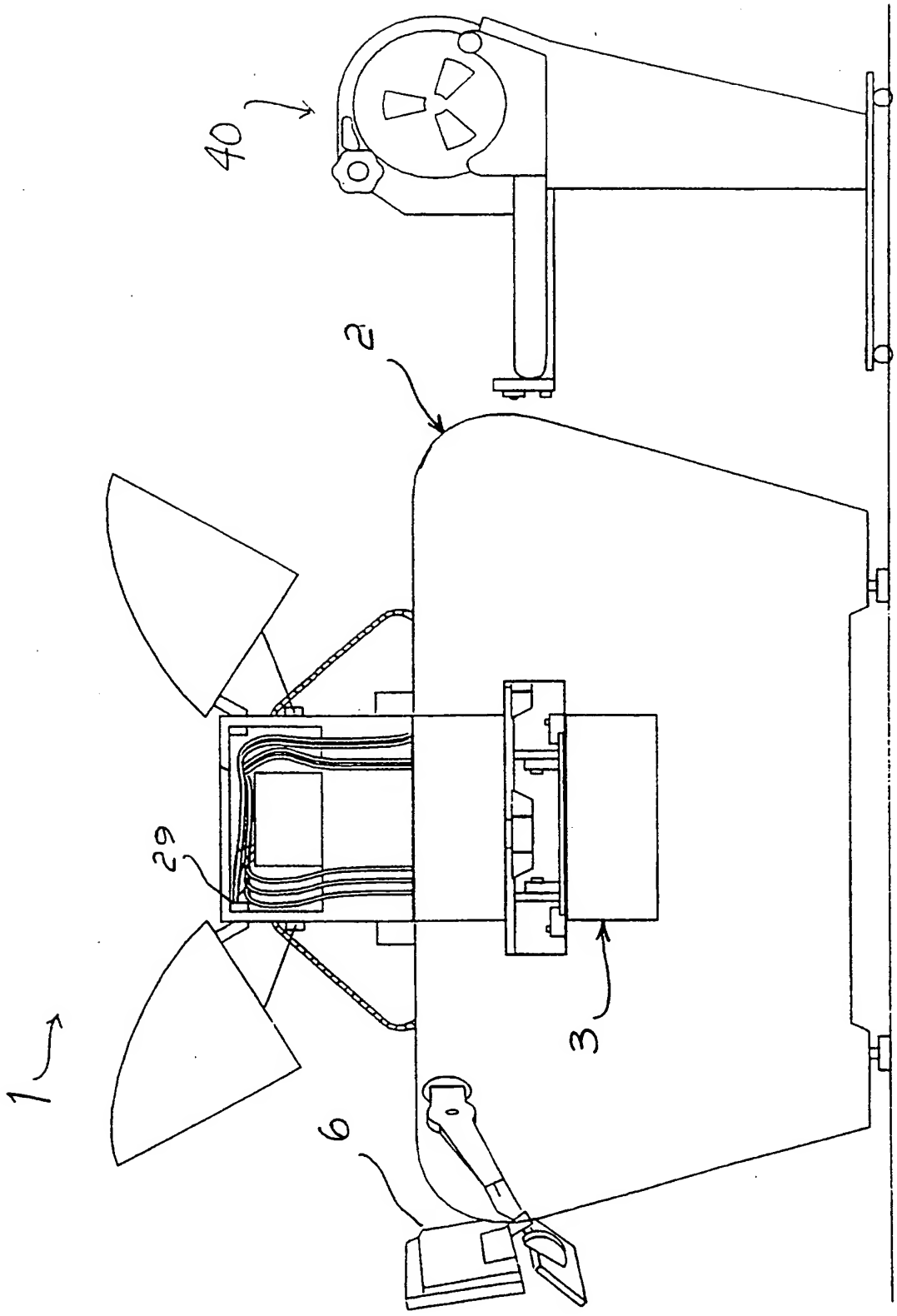


Fig. 1

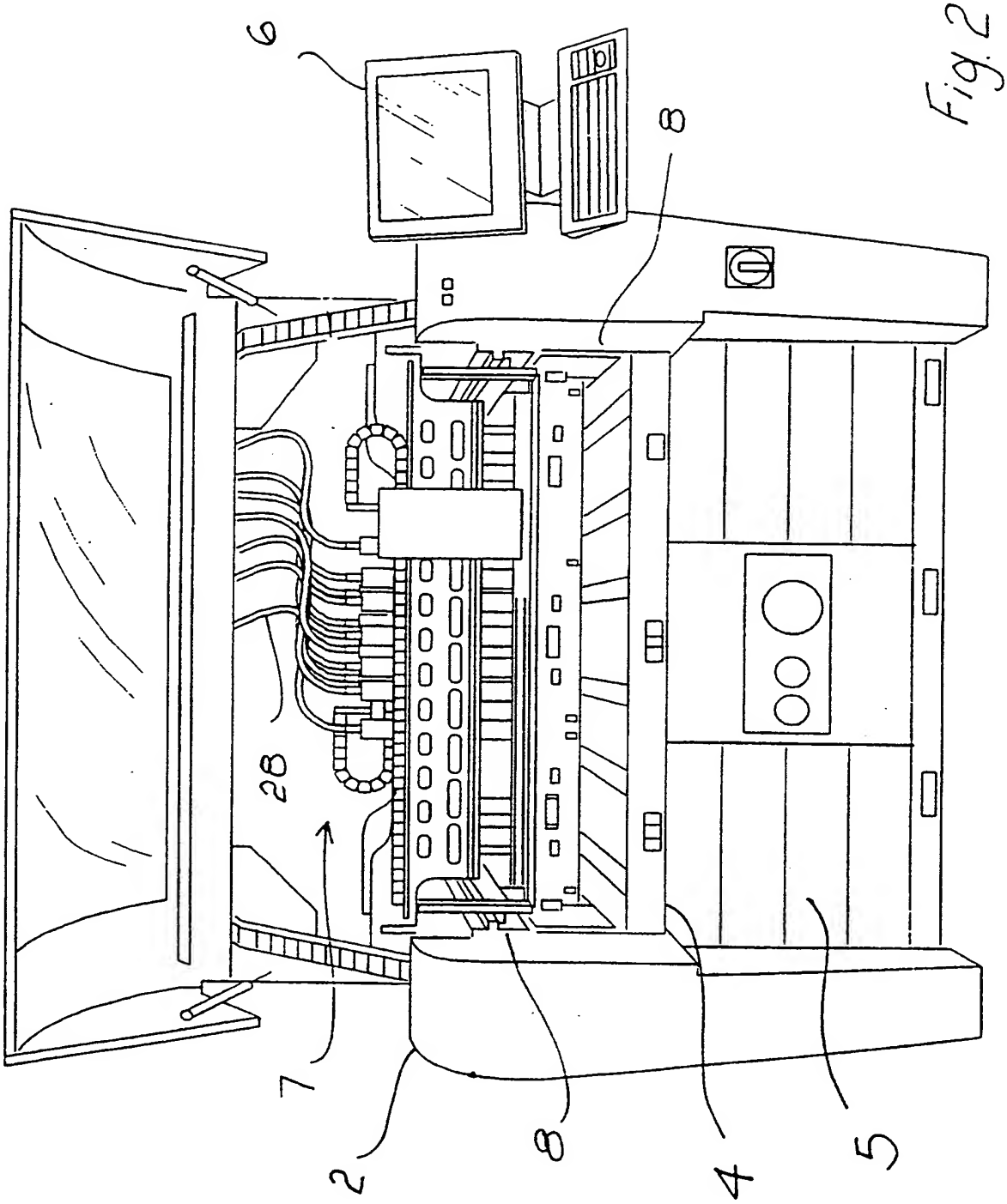


Fig. 2

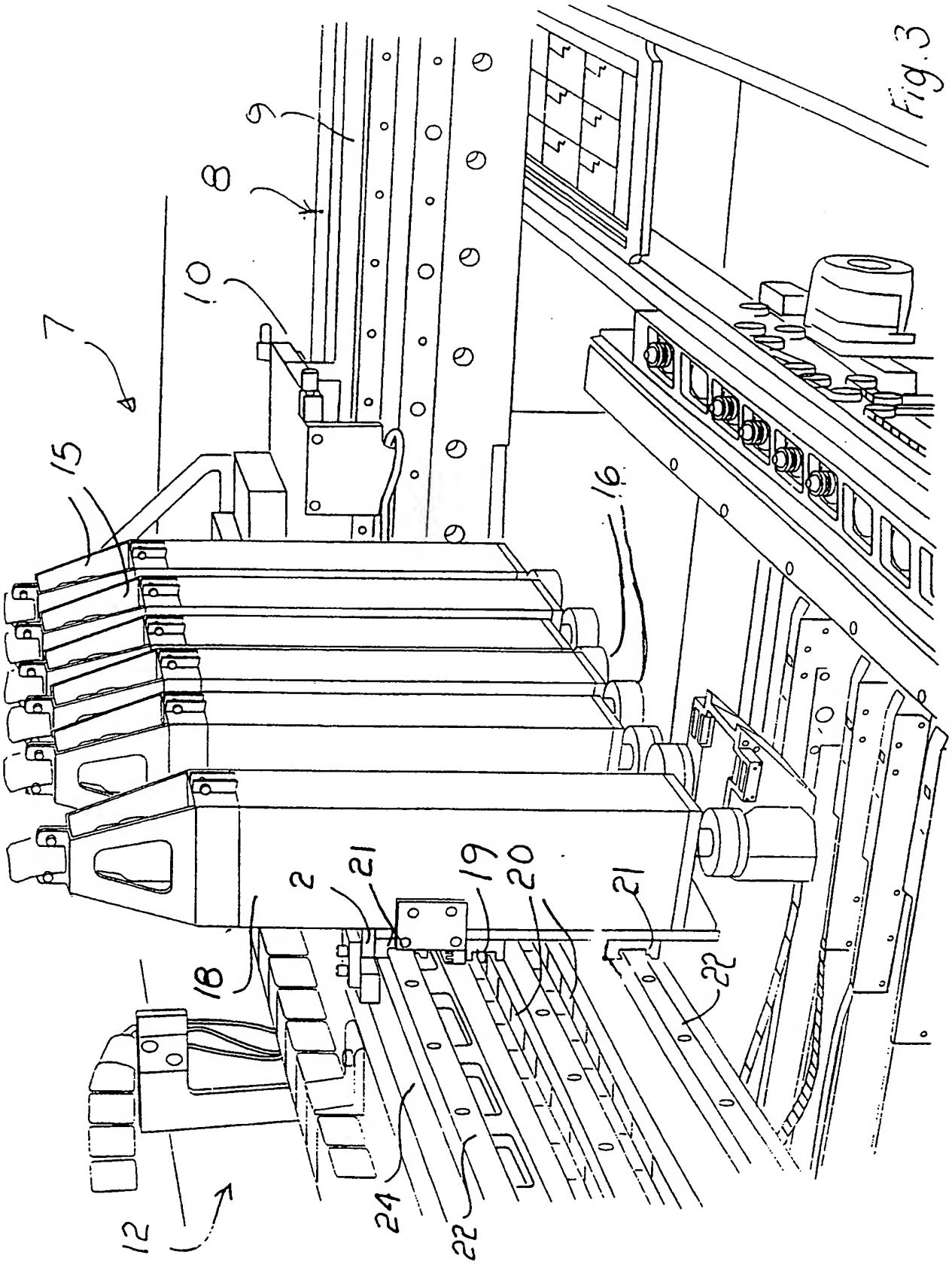


Fig. 3

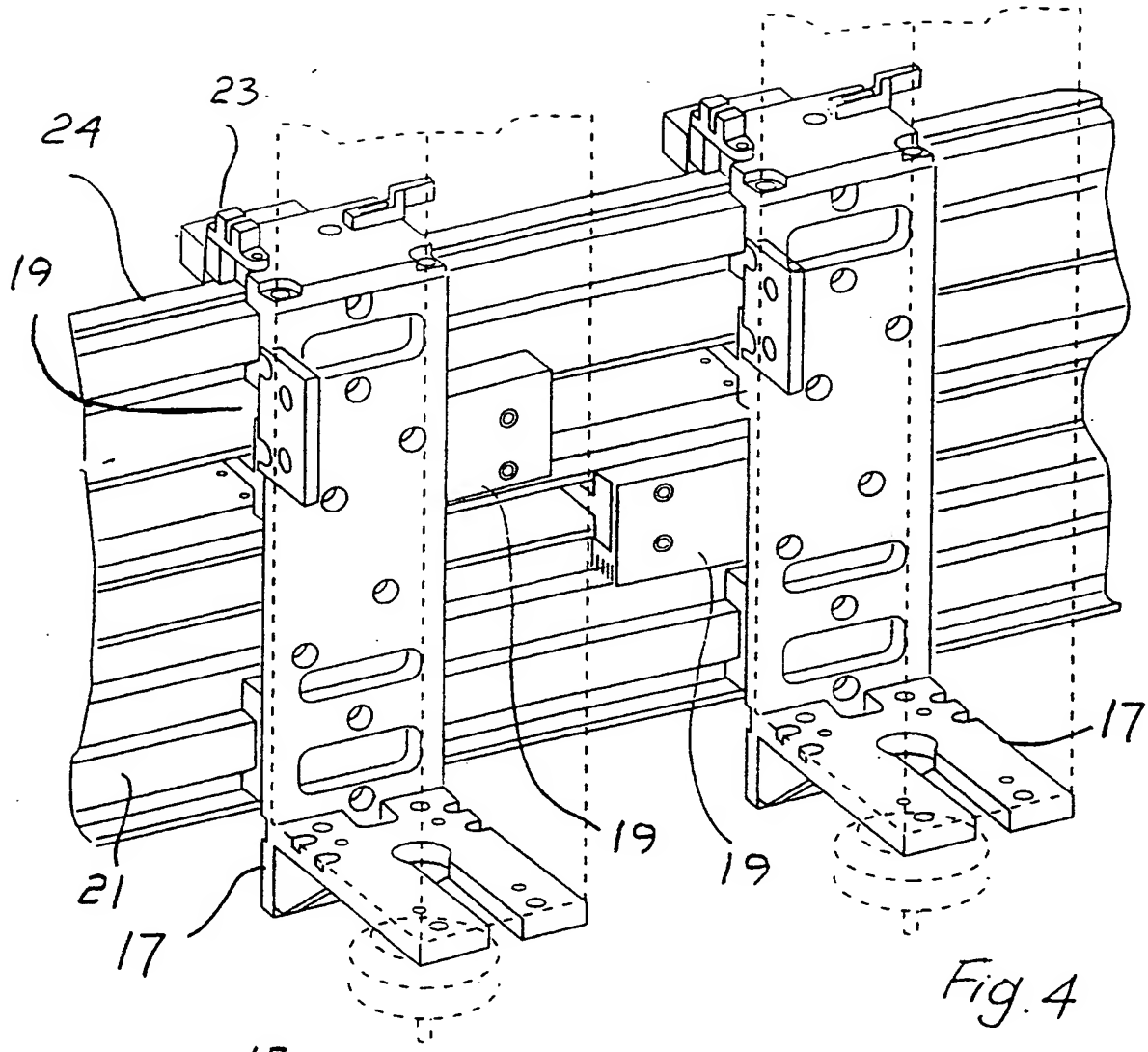


Fig. 4

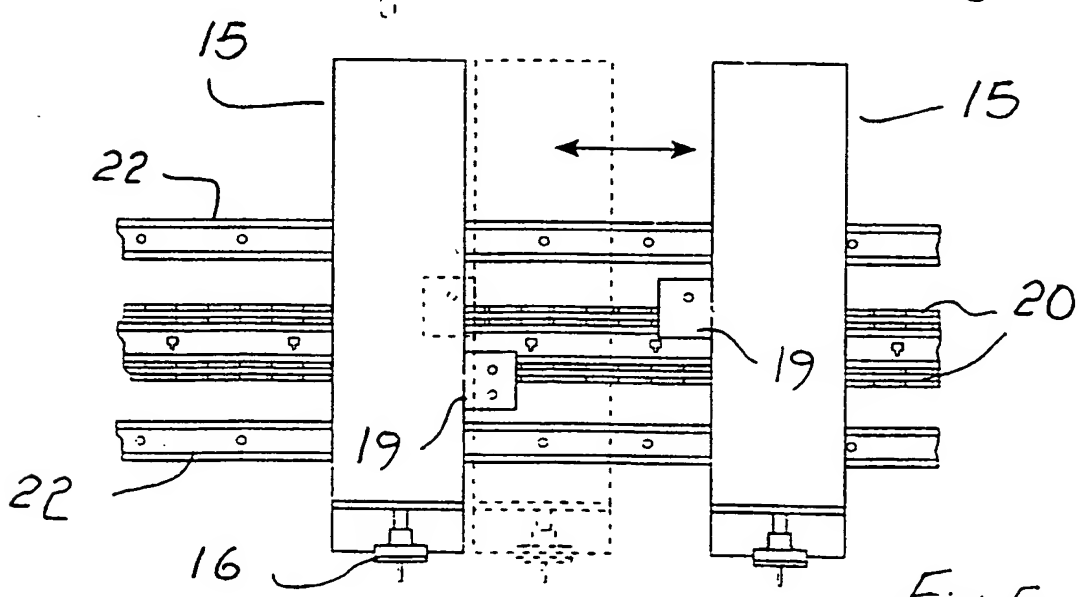


Fig. 5

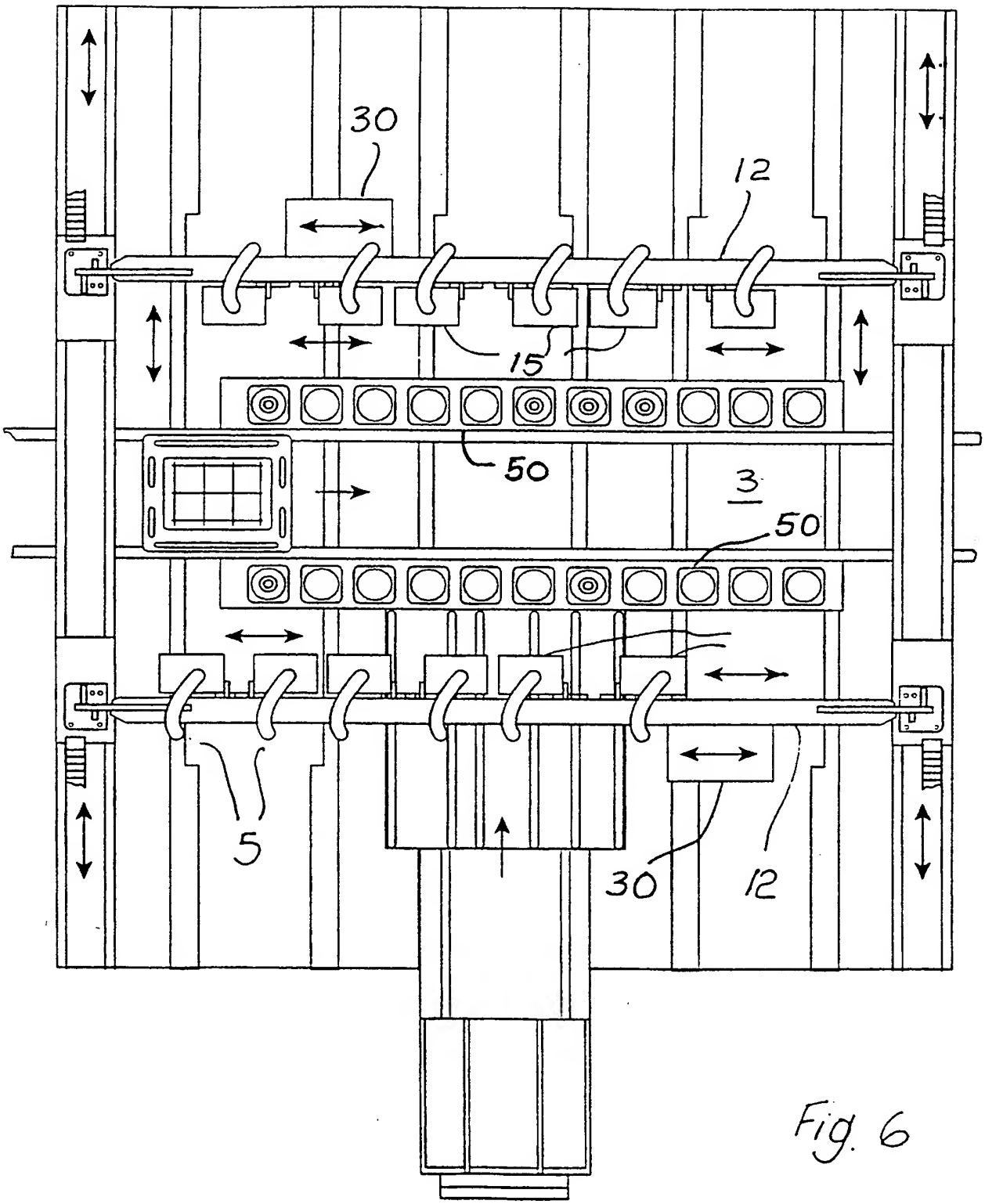


Fig. 6

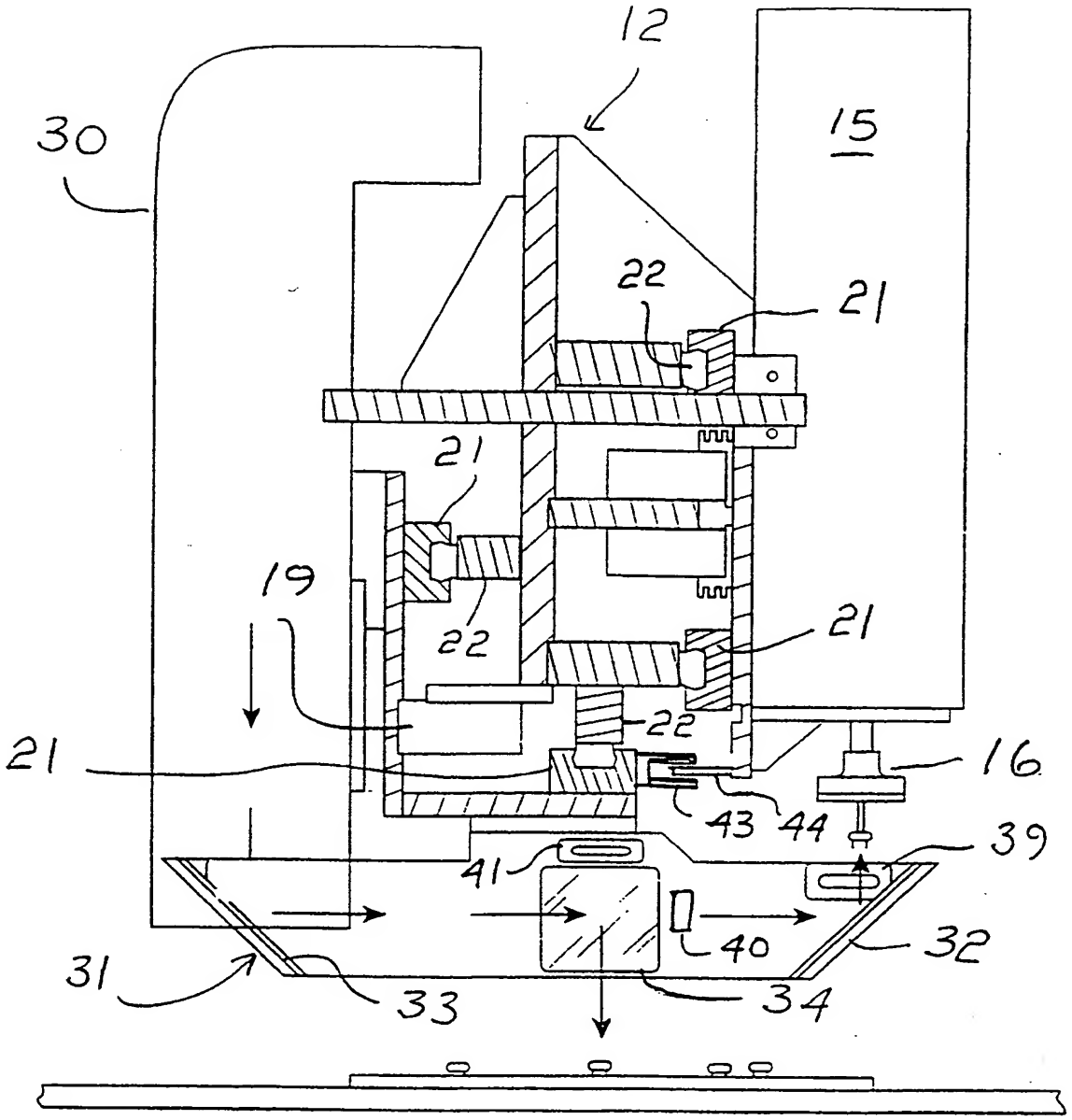


Fig 7

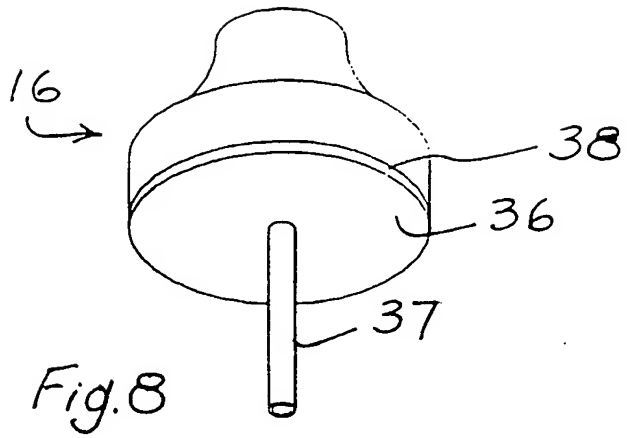
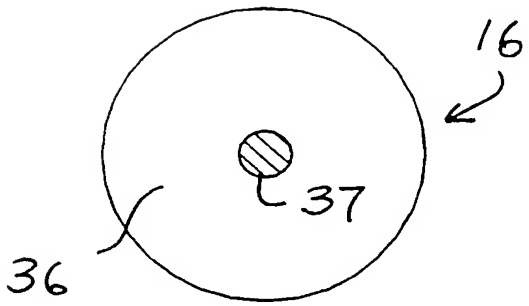


Fig.8



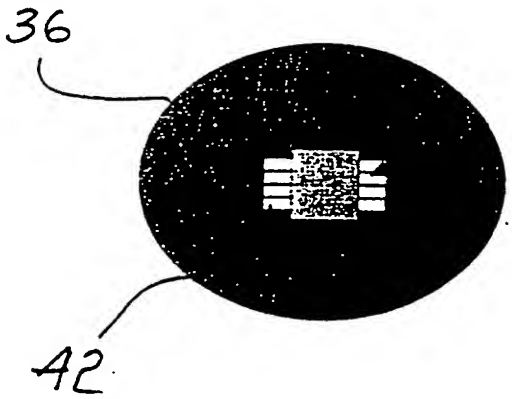


Fig. 9

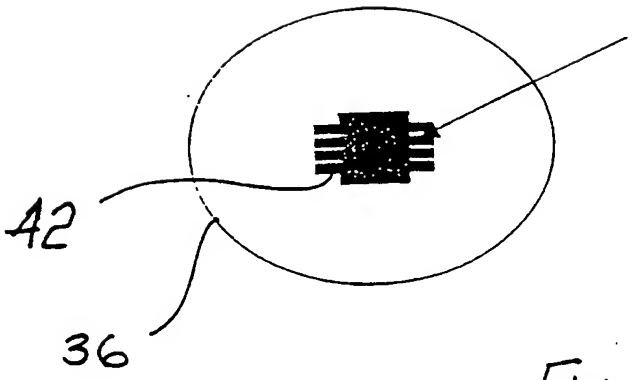


Fig. 10

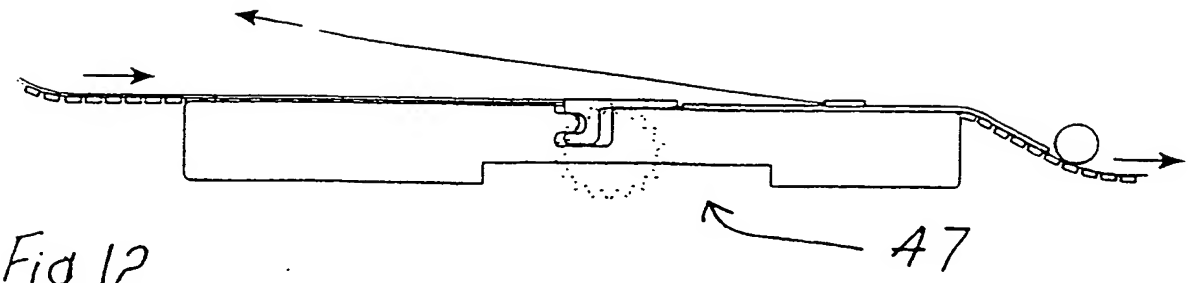


Fig. 12

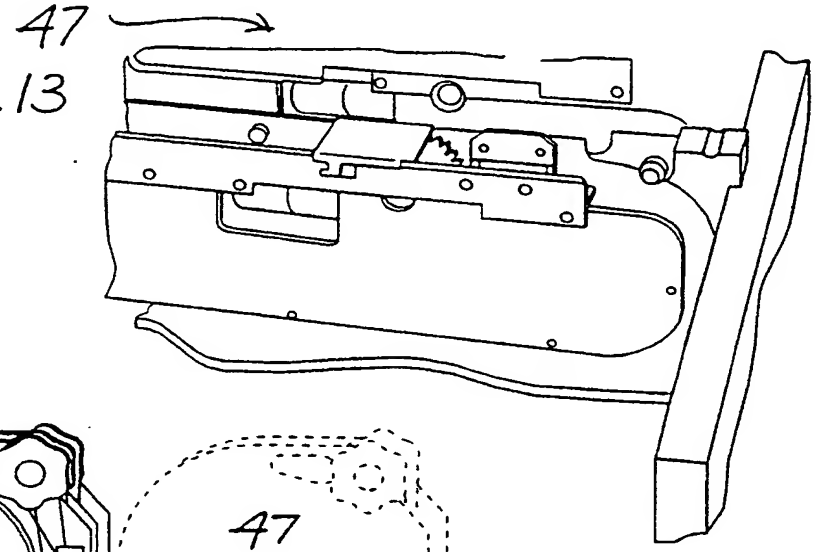


Fig. 13

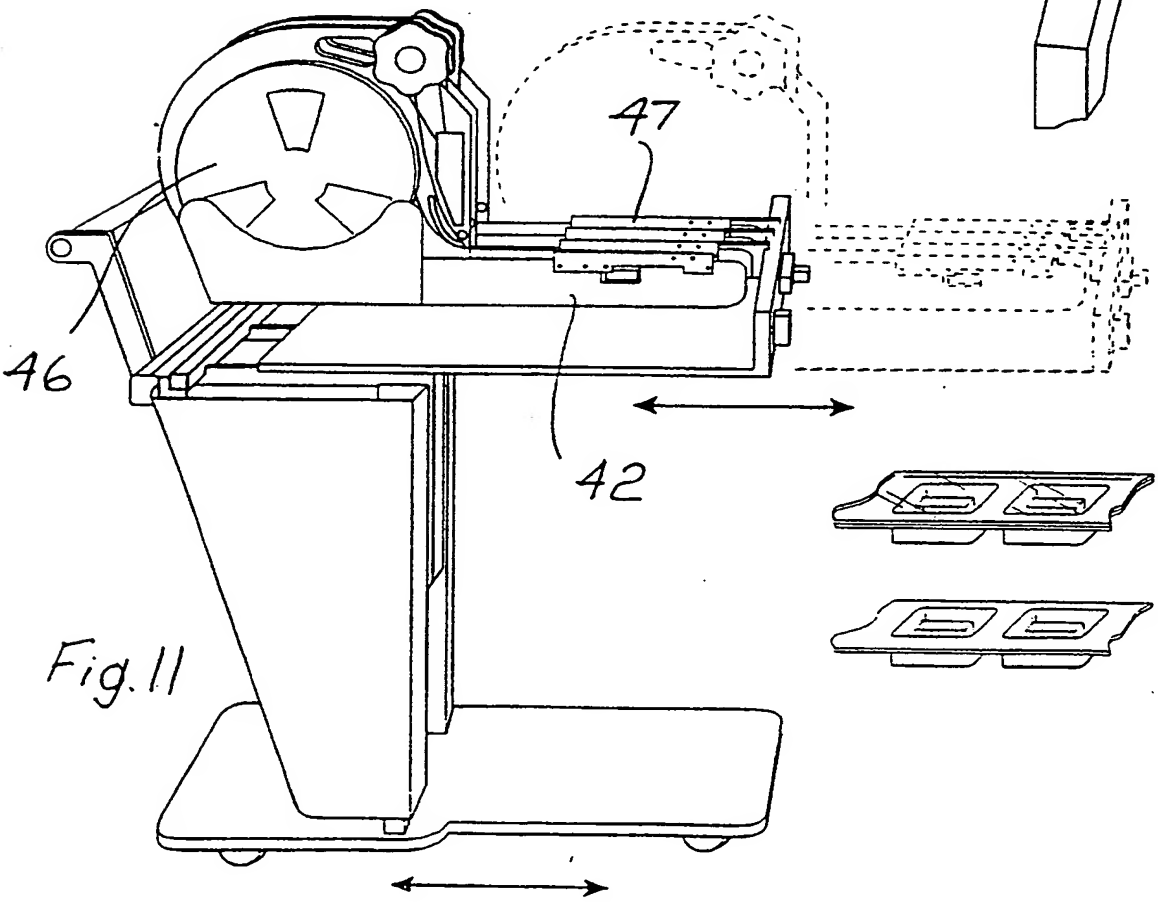


Fig. 11

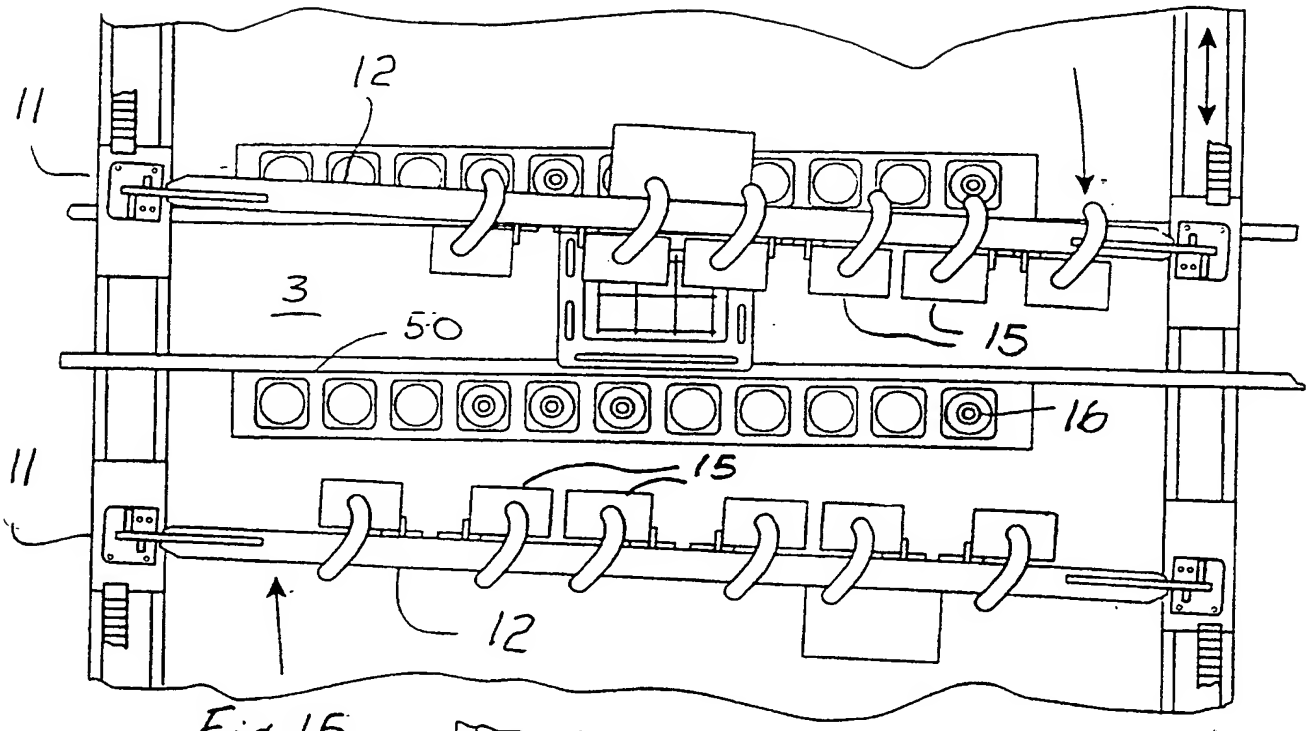


Fig. 15

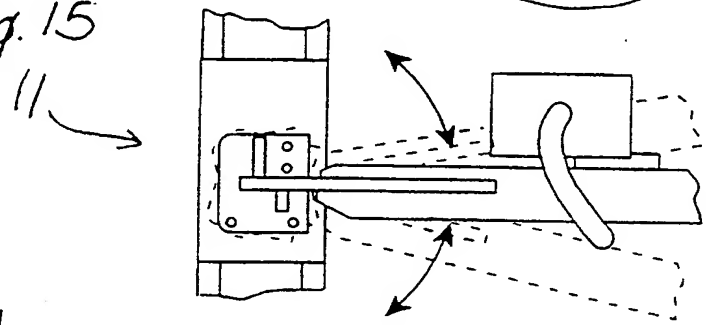


Fig. 14

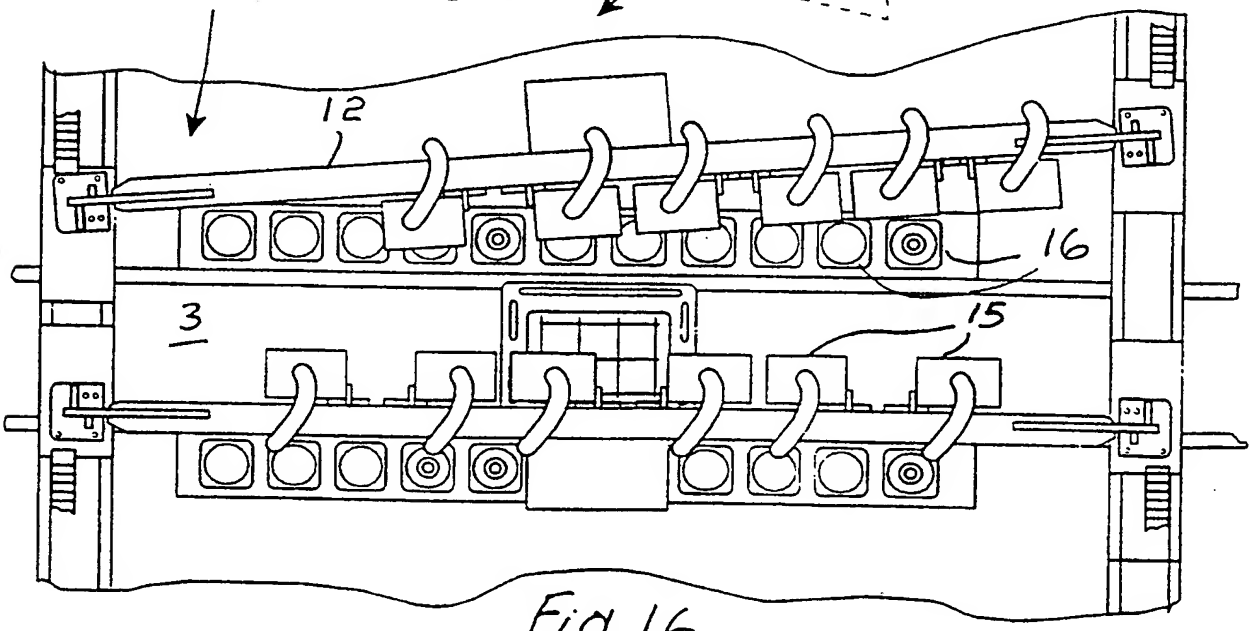


Fig. 16

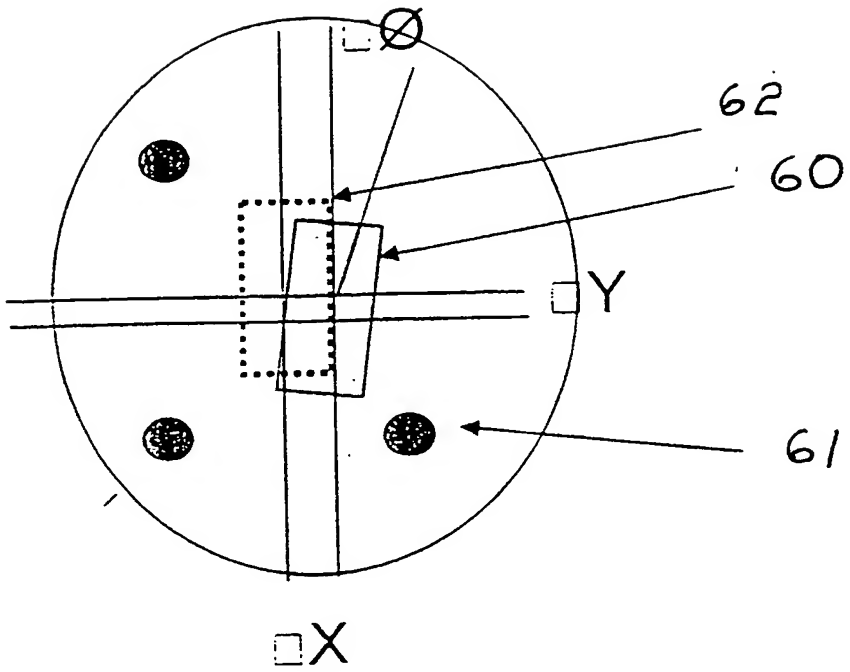


Fig. 17

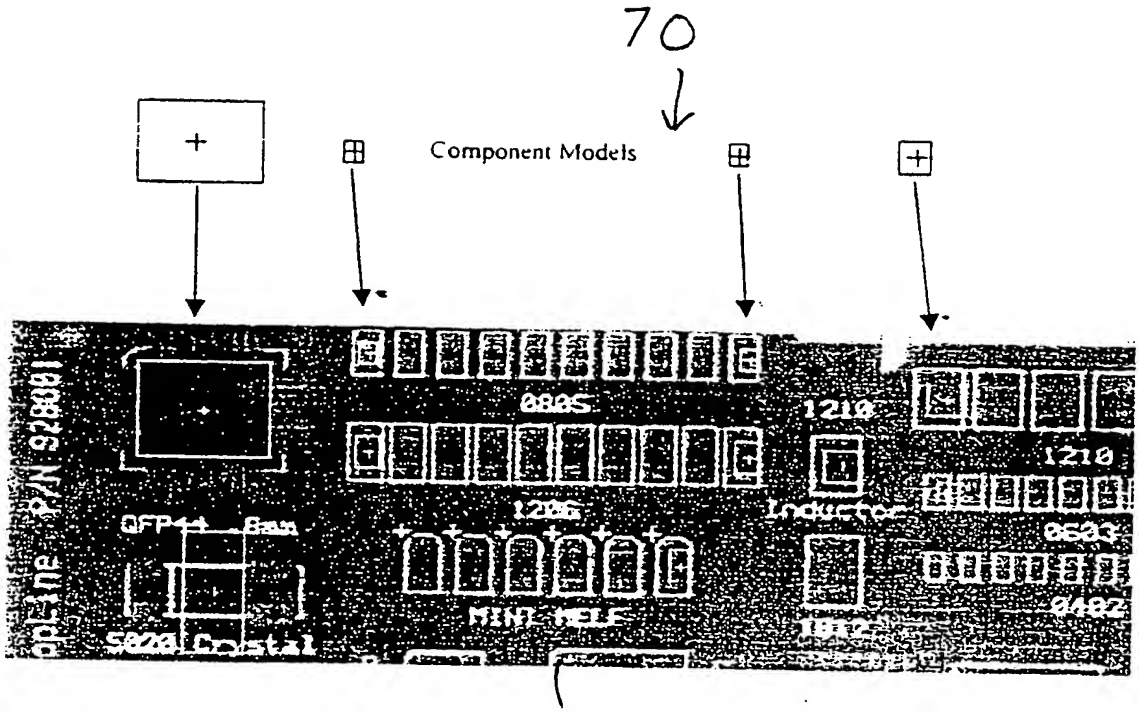


Fig. 18

INTERNATIONAL SEARCH REPORT

Inter ɔnal Application No
PCT/IE 98/00109

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H05K13/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H05K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 18, no. 577 (E-1625), 4 November 1994 & JP 06 216583 A (MATSUSHITA ELECTRIC IND CO), 5 August 1994 see abstract ---	1,2,19, 26
X	PATENT ABSTRACTS OF JAPAN vol. 97, no. 11, 28 November 1997 & JP 09 181492 A (YAMAHA MOTOR CO LTD), 11 July 1997 see abstract ---	1,3,4, 26,27
A	PATENT ABSTRACTS OF JAPAN vol. 98, no. 2, 30 January 1998 & JP 09 275299 A (MATSUSHITA ELECTRIC IND CO LTD), 21 October 1997 see abstract ---	1-4,26

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 April 1999	13/04/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Bolder, G

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INTERNATIONAL SEARCH REPORT

Inter onal Application No
PCT/IE 98/00109

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category '	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 323 528 A (BAKER) 28 June 1994 see column 3, line 61 - column 4, line 31; figures 1,3,4 -----	1,3,4, 19,27,28

2

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte onal Application No
PCT/IE 98/00109

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5323528 A	28-06-1994	NONE	